Non-invasively predicting response to neoadjuvant chemotherapy in gastric cancer via deep learning radiomics

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Gastric cancer is one of the most common malignancies, ranking fifth in incidence and third in mortality worldwide.[1] The high mortality rate is mainly caused by delayed early diagnosis and inappropriate choice of treatment. Neoadjuvant chemotherapy (NACT) combined with surgery is recommended as one of the routine treatment options for locally advanced gastric cancer (LAGC).[2] However, clinical practice has found that NACT is not effective for all patients, and there are significant individual differences in its therapeutic effect among patients.[3] Timely and accurate detection of the therapeutic effect can provide an important reference for clinical treatment decision-making—e.g., reducing the toxicity of chemotherapy in patients who do not respond to treatment and preventing delays in their chances of surgical treatment.

Considering that conventional needle biopsy, biomarkers, and imaging signs cannot accurately and quantitatively predict the efficacy of NACT, as recently reported in *eClinicalMedicine*, researchers constructed a deep learning radiomic nomogram (DLRN) based on a pre-treatment CT scan to deal with this problem.[4] This retrospective study included 719 patients with LAGC from four hospitals. The researchers extracted the handcrafted and deep learning features of the tumor region from a venous CT image, and combined the radiomics signatures and significant clinical factors into the DLRN by multivariate logistic regression. The performance measurement was conducted based on one internal test set and two external test sets, which showed that the DLRN had a higher prediction accuracy for the efficacy of NACT compared with conventional factors. As CT is recommended by guidelines for pre-treatment examination for LAGC, the DLRN is expected to provide the clinicians auxiliary diagnostic information for individualized treatment.

The above research used the method of model construction based on radiomics. Radiomics uses artificial intelligence to map images to clinical tasks by extracting high-throughput quantitative features associated with tumor phenotypes from medical images. The comprehensiveness, adequacy, and timeliness of radiomics signatures in tumor measurement are unmatched by the diagnostic protocols provided by clinical guidelines. The development of radiomics brings new opportunities for the improvement of clinical diagnosis of patients with gastric cancer. Recently, studies have shown that radiomics can effectively model the association between gastric cancer images and clinical events such as histological type,[5] pathological stage,[6,7] and prognosis.[8]

Using artificial intelligence technology such as deep learning to automatically learn quantitative representation from medical images is the development trend of radiomics research. It effectively expands the set of radiomics features with substantial clinical relevance, and provides a novel valuable approach for model construction in radiomics.[9] However, it should be noted that there is no clear theoretical guidance or consensus rules of thumb on how to set a specific deep learning network architecture in the current research on radiomics. Typically, researchers should start with published network structures that have been proven to work in related tasks, and refine them through lots of experiments. In the article,[4] researchers used the Densenet-121 structure, which has shown excellent performance in natural image classification tasks, and used ImageNet data sets for network pre-training. This strategy enabled feature extraction to effectively emphasize complex texture details within the tumor region with enough generalization. By contrast, to further improve the pertinence of medical-related information mining,

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it is necessary to design a network architecture more suitable for the clinical task. However, these often depend on the experience and time of researchers and cannot ensure that the obtained scheme is close to optimal. Neural Architecture Search (NAS) provides a solution to the above problems. It automatically designs high-performance structures for a given task through reinforcement learning or evolutionary algorithms, and has been applied in some medical image segmentation studies.[10]

In addition to further improving the feature extraction methods, researchers and clinicians still need to overcome several limitations to promote the application of radiomics models in clinical practice. For example, privacy protection and feature domain drift exists between different centres, as well as the fact that the continuous enrolment of patients in clinics makes the training data source gradually increase in size. Therefore, strategies such as online learning and distributed learning are being developed to improve the practicability of radiomics. In addition, the generalisable value of the radiomics model needs to be tested on large-scale prospective multicentre datasets to obtain a more reliable performance evaluation in low-bias cohorts. Furthermore, for revealing the actual impact of models on clinics, it is necessary to conduct interventional randomised controlled trials and assess the difference in benefits between the experimental group and control group.

Contributors

All authors contributed to conceptualisation, writing, reviewing, editing, and have read and agreed to the published version of the manuscript.

Declaration of interests

We declare no competing interests.

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